7. *Adeorbis suturalis,* A. Adams.

A. testa ovato-discoidali; spira prominula, albida, tenui, semipellucida, striis incrementi radiatim ornata; anfractibus rapide crescentibus, prope suturas subcarinatis, ultimo ad peripheriam subangulato, suturis canaliculatis; umbilico angusto, margine rotundato; labro mediocri.

Hab. Tsu-Sima; 26 fathoms.

8. *Adeorbis japonica,* A. Adams.

A. testa discoidali; spira depressa, alba, nitida, tenui, semidiaphana, radiatim striata; anfractibus regulariter crescentibus, convexiusculis; umbilico patulo, margine valde carinato; labro mediocri.

Hab. Mino-Sima; 63 fathoms.

9. *Adeorbis nanula,* A. Adams.

A. testa ovata, subconvexa, tenui, semidiaphana, nitida; anfractibus rapide crescentibus, convexiusculis, ultimo subventricoso, ad peripheriam angulato; umbilico angusto, margine rotundato; labro mediocri.

Hab. Mino-Sima; 63 fathoms.

Shanghai, China,
January 1, 1861.

XXVII.—*On the Structure of the larger* Foraminifera.

By H. J. Carter, Esq., F.R.S.

In a paper on the Structure of the larger Foraminifera, read before the Bombay Branch of the Royal Asiatic Society (April 11, 1861), the author sums up his observations on the discoidal Foraminifera as follows:—

Test.—The test is situated in the substance of the animal, and (in *Operculina*) consists of the spiral or horizontal lamina and the marginal cord. The spiral lamina, again, is divided into the parts which cover the chambers and those which cover the interseptal spaces: the former are pierced with close-set vertical tubuli, and the latter with more or less scattered minute branches of the interseptal canals. Besides this, there are non-tubular spaces or puncta, more or less regularly scattered over the chambers and interseptal spaces, which answer to the external ends or bases of conical columns of condensed shell-substance, intended apparently for strengthening the test; and these are accompanied, in some species of *Nummulites,* by a horizontal branch-work of the same material, which gives them very much the appearance of the lacunæ and their canaliculi in bone; yet

they present no appearance of channelling, but, on the contrary, a heterogeneous composition, as regards size, of small pillars and pellets of condensed shell-substance respectively. The marginal cord, on the other hand, is composed of spicules, an interspicular substance, and canals, which are more or less arranged in layers respectively, radiating from the centre of the base of the cord (which is straight) to its circumference (which is semicircular). The spicules overlap each other longitudinally, and the canals form a densely reticulated structure throughout the substance of the cord, whose branches open in all directions upon its surface. As the test arrives at its full growth, the marginal cord is bent down over the last chamber to meet its preceding turn, to which it becomes attached, and the *Operculina* is thus hermetically sealed. Hence D'Orbigny's original statement that the test is without an opening like that of Nautilus and the Ammonites, and without a siphon.

Canal-system.—The canal-system consists of—1. Two great spiral canals, one in each horizontal half of the test, which run from its commencement to its termination, and are situated respectively on each side of the marginal cord, at its point of junction *externally* with the spiral lamina, in which line also it opens externally by fine ramusculi, like those of the interseptal canals. 2. The interseptal canals, two in each interseptal space, which arise respectively from the great spiral canals of the preceding turn, and terminate on the *inner* aspect of the cord, close to the chamber, where they divide into branches which join the marginal plexus, the great spiral canals, and open externally on the surface of the cord, respectively. 3. The marginal plexus, which occupies the marginal cord, and is formed of an intricate network of canals derived chiefly from branches of the great spiral and interseptal canals, which network is spread throughout the cord, and, as before stated, opens in all directions over its surface. 4. A system of small canals, which open on the surface along the lines of the great spiral canals and interseptal spaces, and are in connexion with the spiral and interseptal canals respectively.

Animal.—This, as was discovered by Dujardin, is a Rhizopod, which fills more or less all the chambers and canals of the test, besides spreading over its surface externally: hence M. D'Orbigny was not far wrong when he stated, or M. De Férussac did for him (Ann. des Sc. Nat. t. vii. p. 100, 1826), "que le test de ces petites coquilles était entièrement renfermé dans le corps," though he was wrong for the time in taking the rhizopodous extensions for the arms of a Cephalopod, as he subsequently admitted. The chambers consist of cavities of this sarcode, which are more or less filled with propagative spherules, &c., as

will be more particularly mentioned directly. They communicate by short branches with the great spiral and interseptal canals, the marginal plexus, and with each other through the interseptal spaces, besides opening on the surface through the tubuli. The sarcode of the canal-system is also more or less tubular, and thus affords a transit for the contents of the chambers externally; probably, however, not "tubular" as the word is generally understood, but sarcodal, *through* the *substance* of which the materials for excretion are transmitted, as in *Amœba*.

Besides the propagative spherules, the chambers contain starch, in grains and amorphous, which still more nearly allies the Foraminifera to *Spongilla*, and probably to all the Sponges; for as starch abounds in the former, it may be assumed to be present also in the latter. Whether the chambers contain any other than the propagative organs remains for future research to determine. It is not improbable, also, that they have each a *nucleus*.

As regards nutriment, this may be enclosed by the sarcode, and a stomachal cavity extemporized for digestion at any part; while the egesta may be ejected through the sarcode direct, or through the larger tubes of the canal-system. Lastly, the smaller canals which open over the great spiral canals and interseptal spaces may be for the purpose of admitting water into the larger canals, and thus afford a water-circulation.

Propagative Spherules.—These are produced in the chambers, and are of two kinds, viz. large and small. The small spherule is composed of a homogeneous sphere of matter, slightly tinged yellow by iodine, which is enclosed in a delicate transparent spherical capsule, and attached in massive groups to branched stems, like grapes; while the large spherule consists of a sphere of granular substance, equally tinged yellow by iodine, and sometimes also surrounded by a transparent delicate spherical cell. The former are about 1-5400th and the latter 1-1800th of an inch in diameter. The chambers may be more or less filled with both kinds of spherules, together or separately, and the smaller may be the earlier stage of the larger, if they be not sperm-cells; while they may also be observed, on their transit to the exterior, in *all* parts of the canal-system, even to the vertical tubuli, where their elongation in the fossil species (*Nummulites*) at once points out their softness and adaptation in this respect to the canal through which they may have to pass; but, from being of different sizes below the largest, above mentioned, they for the most part take the largest or smallest tubes for outlets, according to their size. This variation in size may also account for the variation in size of the primary cell of the full-grown species, which is sometimes as small nearly as the smallest

spherule, and at others much larger than the largest. Those which are observed about the test externally are white when dry, so that they already contain calcareous matter. Sometimes the spherule or primary cell begins to develope a second while still in the parent-chamber (I have seen this in one of the chambers in the outer turn of *Nummulites Ramondi*; indeed, I have the section showing it); and then the young one evidently becomes too large for passage through the ordinary chambers. In this case it would seem that a special opening is formed for their exit through the spiral lamina; for holes exist here and there in this part of the test, which, from their rounded edges, indicate that they were made by the animal. Not unfrequently these are formed opposite the great spiral canals.

Mode of Development.—The spherule, having left the parent, becomes the primary cell of the new being, and putting forth a stolon, produces another chamber, and so on until a certain number are formed, which are arranged horizontally around the first, and the *Operculina* is developed. The stolon therefore forms part of the canal-system, and the chambers are in this manner developed from it. As development progresses, the chambers which bud from the *margin* of the cord attain their largest size, and then begin to diminish again, until they end in almost nothing, and are closed in, as before stated, by the bending-down of the marginal cord and its union with the preceding turn, when the test is thus hermetically sealed and its form completed. The union between the chambers at their bases is probably only filamentous; for the chambers do not *here* communicate with each other, while the calcareous septa which divide them are frequently united to the marginal cord; and if not in direct contact, they are always more or less scolloped, indicating a round filamentous layer of the sarcode which previously existed between them and the cord. Besides, we shall see presently that the development of the test is frequently continued without the presence of the chambers; so there can be no question that all other structures are developed from the sarcode of the canal-system, or from the filamentous sarcode, connected, of course, originally with a nucleated cell. Hence the filamentous sarcode becomes analogous to the mycelium of Fungi, and being rhizopodous, is united, through the Sponges, to the fungal parasitic animals which inhabit the cells of Algæ and are propagated by monociliated Amœbæ, and, through the latter, to the true Fungi, which are propagated by defined sporules.

Nummulites is nothing but a more complicated form of the *Operculina* type. The chambers bud from the margin of the cord, and extend outwards and inwards until they reach the level of the margin of the last turn and the umbilicus of the

test respectively,—the last three, four, or more, being of successive sizes up to the last of all, which is least developed.

The same principle obtains in the formation of the test and propagation of *Orbitoides dispansa* and *Orbitolites Mantelli*, Cart. (*Orbitoides Mantelli*, D'Orb.); but the canal-system is different, and there are no columns of condensed shell-substance in the latter. In *Orbitoides dispansa* each chamber is united to the two in front and the two behind it by stolon-processes, as in *Cycloclypeus*, Carp.; and there is an annular canal behind each row, which is united, by straight, transverse, interseptal or intercameral branches, with that in front and behind it in each half of the test. The latter system also exists in *Orbitolites Mantelli*; but the stolon-processes are represented by oblique canals which radiate from the centre to the circumference, and here in this manner also unite each chamber with the two in front and two behind it; while, as the chamber becomes vertically elongated towards the circumference, the oblique canals are increased to two, four, and six in number in the outer rows, one above another, so as to resemble their disposition in *Orbitolites*, as shown by Dr. Carpenter's diagram. In the annular canals we cannot help seeing the analogues of the great spiral canals in *Operculina* and *Nummulites Ramondi*, &c., if not in all *Nummulites*; while in the stolon-processes of *Orbitoides dispansa* and the oblique canals of *Orbitolites Mantelli* and *Orbitolites complanata*, we seem to have a combination of the marginal plexus and interseptal canals; for they both open ultimately at the margin or circumference of the tests respectively. The columnar chamber-structure, on the other hand, in both, which corresponds with the vertical development of *Nummulites* (that is, the extension of the chambers to the umbilicus on each side the horizontal plane), has its parts united by ascending and horizontal stolon-processes, which indirectly give existence to the propagative spherules throughout, for the same kind of spherules are developed both in the chambers of the horizontal plane and in the columnar chambers, even to the very centre of these fossils, as in *Nummulites* and *Operculina*.

The tests of *Conulites* (n. gen.) and *Orbitolina lenticularis* are developed upon the same principle as the rest, and both present the same kind of propagative spherules in the chambers. *Conulites*, however, has the same columnar chamber-structure and columns of opake shell-substance as *Orbitoides dispansa*, but with a *helical* layer of chambers externally, something like the horizontal layer of *Nummulites*; while *Orbitolina lenticularis* has no columns of opake matter in its columnar chamber-structure, and has a *cyclical* arrangement of the rows of chambers externally, like *Orbitoides dispansa*, *Orbitolites Mantelli*, and *Orbitolites complanata*.

Alveolina meandrina (n. sp.), and therefore *A. elliptica*, are developed upon the same principle as *Nummulites* elongated vertically. The former has an interseptal system and marginal plexus of canals; and the latter too, probably. In *Alveolina elliptica* the greater part of the test is often without chambers, so that its development is as often wholly carried on by the sarcode of the canal-system; and the same is frequently the case with the last turns of the globose forms of *Nummulites*, e. g. *N. perforata*, &c.; while in *Alveolina elliptica* also, the chambers sometimes disappear and reappear at intervals, leaving the spire to go round by itself between them, as exemplified also in the annular canals of *Orbitolites Mantelli* and *Orbitoides dispansa*. These are the instances to which I have before alluded as evidencing a development of the chambers upon the sarcodal filaments of the canals.

The new genus for which the term "Conulites" above-mentioned is proposed has the following generic characters:—

"Conical, compressed, discoidal; consisting externally of a spiral layer of rhomboidal chambers extending from the apex to the circumference; filled up internally with convex layers of compressed columnar chambers interspersed with white columns of condensed shell-substance; white columns opake, conical, their sharp ends resting on the inner aspect of the spiral layer, and their large ones terminating at the base of the cone, which presents a slightly convex granular surface."

XXVIII.—*A Catalogue of the Zoophytes of South Devon and South Cornwall.* By the Rev. Thomas Hincks, B.A.

[Continued from p. 161.]

[Plates VII. & VIII.]

Order **SERTULARIDÆ**, Huxley. Fam. **Sertulariadæ**, Johnst.

1. Halecium, Oken.

1. *H. halecinum*, Linn.

Very common; abundant and of great size amongst the trawl-refuse.

2. *H. Beanii*, Johnston.

Very common; dredged abundantly all along the coast. Very fine in Salcombe Bay and Torbay. I have a specimen which stands 5 inches high, while the spread of the branches measures 6 inches.

[Lamlash, Arran; Filey, Yorkshire; Llandudno, N. W.; Ramsay, Isle of Man.]